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(21) International Application Number: PCT/FI98/00208 (22) International Filing Date: 10 March 1998 (10.03.98) (30) Priority Data: 970992 10 March 1997 (10.03.97) FI (71) Applicant (for all designated States except US): PARTEK PAROC OY AB [FI/FI]; Sörnäisten rantatie 23, FIN-00500 Helsinki (FI). (72) Inventors; and (75) Inventors/Applicants (for US only): PERANDER, Michael [FI/FI]; Väderkvamsvägen 10, FIN-21600 Pargas (FI). HAKALA, Jan [FI/FI]; Kardinaalinkatu 3 L 108, FIN-20380 Turku (FI). (74) Agent: OY JALO ANT-WUORINEN AB; Iso Roobertinkatu 4-6 A, FIN-00120 Helsinki (FI).		(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG). Published <i>With international search report.</i>
(54) Title: MINERAL FIBRE (57) Abstract The invention concerns a mineral fibre having the following composition in % by weight: SiO ₂ 50-60, Al ₂ O ₃ 1-6, MgO 16-22, CaO 12-18, Na ₂ O + K ₂ O 0-3, Fe ₂ O ₃ 1-8, P ₂ O ₅ 1-6, other 0-3, whereby the weight ratio CaO/MgO < 1 and the sum CaO + MgO = 30-38 % by weight.		

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Mineral fibre

The present invention concerns mineral fibres.

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Mineral fibres made by melting and centrifuging of mineral raw materials, such as rock, slag or similar material, are extensively used for the manufacture of mineral fibre mats and blankets, especially for heat and sound insulation purposes in the construction industry. Consequently a mat of this kind should above all exhibit good insulating properties against heat and sound. In addition, the mat should advantageously exhibit good strength and elasticity, as well as a good temperature resistance. For primarily production economical reasons, it is also important that the mineral melt has an advantageous production technical composition, for example good fiberizability.

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A wide range of insulation products are available on the market, which products do not only have different heat insulation properties, but also a varying degree of temperature resistance. Temperature resistant mineral fibre products mean products which can resist elevated temperatures during prolonged periods of time without changing shape or dimensions to any appreciable degree. Such products are thus attractive from a fire prevention point of view.

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Conventional glass fibre has a temperature resistance of up to appr. 550°C, whereas the temperature resistance of conventional rock wool is better, up to appr. 700°C. However, there is an interest for products with even higher temperature resistance, up to 1100 - 1200°C, and such products are also available on the market.

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In recent times, increased importance has been attached also to the properties of the mat from the point of view of labor hygiene. Thus work has been initiated on developing fibres which have an increased solubility in biological fluids in order to ensure that fibres which during handling of the mineral wool are taken up by the body without being transported out therefrom, disappear by dissolving in the body

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fluid. Such soluble fibres are described, for example, in the EP-patent EP-B-558 548. These fibres possess, as rock wool fibres in general, an increased calcium oxide content with respect to its magnesium oxide content, as magnesium oxide generally is considered to have an undesired increasing effect and calcium oxide a
5 desired decreasing effect on the melt liquidus temperature.

One aim of the present invention is to modify soluble fibres for example of the type described in the said EP-patent in order to make such fibres more temperature resistant. An object of the invention is also to guarantee that the fibre manufacture
10 can take place in an economically advantageous manner, with maintained or improved glass properties of the melt and a decreased risk for premature solidification, and with a good yield of fibres of good quality, for example longer fibres with maintained fibre diameter and fibres with good strength. Such fibres in turn give a fibre mat with improved stiffness, elasticity and heat resistance.

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The above mentioned advantages are achieved with the mineral fibre according to the invention, which in contrast to the fibres according to the EP-B-558 548 contain an increased content of magnesium oxide in relation to the calcium oxide content. It has surprisingly shown that according to the invention, that is with a
20 phosphorus containing fibre with reversed CaO/MgO-ratio, the above mentioned favourable characteristics are achieved, both with respect to fibre manufacture and the fibres obtained and the products made therefrom.

The present invention thus concerns a mineral fibre with the following composition in % by weight

	SiO ₂	50 - 60
	Al ₂ O ₃	1 - 6
5	MgO	16 - 22
	CaO	12 - 18
	Na ₂ O + K ₂ O	0 - 3
	Fe ₂ O ₃	1 - 8
	P ₂ O ₅	1 - 6
10	other	0 - 3

wherein the weight ratio $\text{CaO/MgO} < 1$, and the sum $\text{CaO} + \text{MgO} = 30 - 38 \%$ by weight.

- 15 The denomination "other" components above encompasses such optional components, especially contaminants, which are of no substantial importance with respect to the properties of the manufactured fibre, such as Ti, Zr, Cr, Mn etc, whereby each individual other component preferably is not present in an amount of more than 1 % by weight. In this description, the denomination Fe₂O₃ also means
- 20 bivalent iron FeO.

According to a preferred embodiment, the invention concerns a mineral fibre with substantially the following composition in % by weight

25	SiO ₂	53 - 58
	Al ₂ O ₃	1 - 4
	MgO	17 - 20
	CaO	14 - 17
	Na ₂ O + K ₂ O	0 - 3
30	Fe ₂ O ₃	2 - 6
	P ₂ O ₅	2 - 5
	other	0 - 3

whereby the weight ratio $\text{CaO/MgO} < 1$.

According to a preferred embodiment, the fibre composition contains MgO and CaO in such quantities that the weight ratio CaO/MgO is greater than 0.7, preferably 0.7 - 0.9. According to a further preferred embodiment, the sum $\text{MgO} + \text{CaO}$ = 30 - 37 % by weight, preferably 32 - 35 % by weight.

According to a further preferred embodiment, the invention concerns a mineral fibre which contains 18 - 20 % by weight MgO, especially 18 - 19 % by weight MgO and 15 - 16 % by weight of CaO. One example of such a fibre has a composition containing substantially in % by weight

	SiO_2	54 - 55
	Al_2O_3	2 - 4
15	MgO	18 - 20
	CaO	15 - 16
	$\text{Na}_2\text{O} + \text{K}_2\text{O}$	0 - 2
	Fe_2O_3	2 - 4
	P_2O_5	2 - 4
20	other	0 - 2.

According to a further embodiment of the invention, a mineral fibre contains substantially in % by weight

25	SiO_2	53 - 58
	Al_2O_3	1 - 4
	MgO	16 - 19
	CaO	13 - 16
	$\text{Na}_2\text{O} + \text{K}_2\text{O}$	0 - 2
30	Fe_2O_3	4 - 8
	P_2O_5	1 - 6
	other	0 - 2

whereby the weight ratio $\text{CaO/MgO} < 1$ and $\text{CaO} + \text{MgO} \geq 30$.

According to still a further embodiment of the invention, a preferred mineral fibre contains substantially in % by weight

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	SiO_2	53 - 56
	Al_2O_3	1 - 4
	MgO	16 - 18
	CaO	13 - 15
10	$\text{Na}_2\text{O} + \text{K}_2\text{O}$	0 - 2
	Fe_2O_3	6 - 8
	P_2O_5	4 - 6
	other	0 - 2

whereby $\text{CaO} + \text{MgO} \geq 30$.

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According to the invention it has been found that by using an increased iron oxide content in the composition, it is possible to increase the service temperature of the fibre product even to values up to and above 1000 °C.

20 The composition according to the invention is prepared in a conventional manner by mixing and melting of suitable raw materials. Such raw materials are for example olivine-serpentine-talcum based minerals, fayalite, kimberlite, peridotite, quartz, quartz sand, diatomite, wollastonite, apatite or synthetic phosphate, cement, lime, low-aluminium slag, etc. The composition according to the invention can be
 25 used for manufacturing fibres in a conventional manner, for example by cascade centrifugation of the melt obtained.

The raw materials may be used either as such, ground and sorted in a suitable piece or particle size, or as ready-made briquettes with a suitable composition,
 30 used alone or comprising a part of the charge.

The following examples illustrate the invention without restricting the same.

A cupola furnace is charged with raw materials chosen from those listed above in suitable amounts to give the desired composition of the fibre product. Fibres were
5 made from the melt obtained in a conventional manner by cascade centrifugation, which fibres were collected on a conveyor to form a mineral fibre web.

In the following Table, the examples 1 - 6 indicate compositions for fibres according to the invention, whereas the examples indicated Ref. A, Ref. B and Ref. C
10 are reference compositions.

Ref. A is a rock wool composition with a conventional ratio CaO/MgO, but containing no phosphorus, whereas Ref. B is a rockwool composition with a "reversed" CaO/MgO-ratio, also containing no phosphorus. Ref. C is a rockwool composition with conventional CaO/MgO-ratio which also contains phosphorus.
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Table

Composition	Ref. A	Ref. B	Ref. C	1	2	3	4	5	6
SiO ₂	52.0	56.0	51.0	53.7	54.5	54.3	55.7	53.7	54.3
Al ₂ O ₃	3.9	2.6	2.8	2.1	3.7	2.7	2.1	2.9	1.5
MgO	14.2	17.2	14.7	16.7	19.3	18.2	19.1	18.3	18.6
CaO	22.0	15.7	18.3	13.6	15.3	15.6	14.9	16.4	13.3
Na ₂ O + K ₂ O	0.9	1.0	1.0	0.5	1.0	0.5	0.4	0.7	1.3
Fe ₂ O ₃	5.5	6.0	6.7	7.4	2.8	4.2	3.1	2.8	6.3
P ₂ O ₅	0	0	4.2	4.2	2.6	3.3	3.7	3.8	3.9
Other	1.0	1.5	1.3	1.8	0.8	1.2	1.0	1.4	0.8
Sintering temp. °C	1210	1270	1120	1170	1170	1220	1220		
Max. service temp. °C			690	1120	730	750	750		
Dissolution (ng/cm ² h)		200	500	580					
Fibre yield (%)	45		66	67	70	64	68		
Shot (%)	10		5	3	3,5	8	4		

From the Table it can be seen that when the CaO/MgO-ratio is reversed as compared to the conventional ratio (Ref. A -> Ref. B), the sintering temperature of the wool increases, that is its temperature resistance increases. This increase in temperature resistance allows for the inclusion of phosphorus, which has a sintering temperature reducing effect (Ref. A -> Ref. C). The addition of phosphorus is needed for increasing the fibre solubility in biological fluids.

By reversing the CaO/MgO-ratio, in accordance with the invention, compositions 1 - 6, an increase in the temperature resistance can be seen, compared to Ref. C. The difference can be seen in the sintering temperature, but also in the temperature indicating the maximum service temperature. Especially high service temperatures have been obtained for the composition 1 having a high iron content.

The compositions according to the invention also give, as compared for example to composition Ref. A, a significantly better fibre yield and smaller shot content, due to the beneficial effect of phosphorus on the fibre production, as a result of the viscosity increasing effect of phosphorus on the melt. In addition, the fibre compositions containing phosphorus are more soluble than the phosphorus-free compositions (Comp. 1 vs. Ref. B).

Claims

1. Mineral fibre, **characterized** in that it has the following composition in % by weight:

SiO ₂	50 - 60
Al ₂ O ₃	1 - 6
MgO	16 - 22
CaO	12 - 18
Na ₂ O + K ₂ O	0 - 3
Fe ₂ O ₃	1 - 8
P ₂ O ₅	1 - 6
other	0 - 3

whereby the weight ratio $\text{CaO/MgO} < 1$ and the sum $\text{CaO} + \text{MgO} = 30 - 38 \%$ by weight.

2. The mineral fibre according to claim 1, **characterized** in that it has the following composition in % by weight:

SiO ₂	53 - 58
Al ₂ O ₃	1 - 4
MgO	17 - 20
CaO	14 - 17
Na ₂ O + K ₂ O	0 - 3
Fe ₂ O ₃	2 - 6
P ₂ O ₅	2 - 5
other	0 - 3

3. The mineral fibre according to claim 1 or 2, **characterized** in that the composition contains MgO and CaO in such amounts that the ratio CaO/MgO is greater than 0.7, preferably 0.7 - 0.9.

4. The mineral fibre according to any one of the claims 1 - 3, **characterized** in that in the composition, the sum $\text{MgO} + \text{CaO} = 30 - 37$, preferably $32 - 35$ % by weight.

5. The mineral fibre according to any one of the claims 1 - 4, **characterized** in that it contains $18 - 20$ % by weight of MgO and $15 - 16$ % by weight of CaO .

6. The mineral fibre according to claim 5, **characterized** in that it has a composition containing in % by weight

SiO_2	54 - 55
Al_2O_3	2 - 4
MgO	18 - 20
CaO	15 - 16
$\text{Na}_2\text{O} + \text{K}_2\text{O}$	0 - 2
Fe_2O_3	2 - 4
P_2O_5	2 - 4
other	0 - 2.

7. The mineral fibre according to claim 1, **characterized** in that it has a composition containing in % by weight

SiO_2	53 - 58
Al_2O_3	1 - 4
MgO	16 - 19
CaO	13 - 16
$\text{Na}_2\text{O} + \text{K}_2\text{O}$	0 - 2
Fe_2O_3	4 - 8
P_2O_5	1 - 6
other	0 - 2

8. The mineral fibre according to claim 7, **characterized** in that it has a composition containing in % by weight

SiO ₂	53 - 56
Al ₂ O ₃	1 - 4
MgO	16 - 18
CaO	13 - 15
Na ₂ O + K ₂ O	0 - 2
Fe ₂ O ₃	6 - 8
P ₂ O ₅	4 - 6
other	0 - 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 98/00208

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: C03C 13/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: C03C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 9414718 A1 (ROCKWOOL INTERNATIONAL A/S), 7 July 1994 (07.07.94), abstract, Table 1 --	1-8
A	US 5583080 A (MARIANNE GULDBERG ET AL), 10 December 1996 (10.12.96), Table 1 -- -----	1-8

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Information on patent family members

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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